Accelerating event based simulation for multi-synapse spiking neural networks

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Abstract. The simulation of large spiking neural networks (SNN) is still a very time consuming task. Therefore most simulations are limited to rather unrealistic small or medium sized networks (typically hundreds of neurons). In this paper, some methods for the fast simulation of large SNN are discussed. Our results equally amongst others show that event based simulation is an efficient way of simulating SNN, although not all neuron models are suited for an event based approach. We compare some models and discuss several techniques for accelerating the simulation of more complex models. Finally we present an algorithm that is able to handle multi-synapse models efficiently.

1 Introduction

Despite the ever increasing computational power in computer systems, there is still a huge demand for more computational power, especially in the field of spiking neural networks (SNN). Spiking neurons are biologically inspired neurons that communicate by using spikes. Because here the timing of the spikes is considered, SNN are able to handle temporal problems more efficiently (for example speech recognition [18]) and have more computational power than artificial neural networks [9] which use the average firing rate of neurons as inputs. Furthermore, they communicate through discrete spikes instead of analog values which significantly reduces the communication costs between neurons. This makes them particularly better suited for hardware implementations [13][14].

The behaviour of a spiking neuron can be represented by an internal membrane potential which is influenced by incoming spikes. When the potential of the membrane reaches a certain threshold value, the membrane potential will be reset to a lower value and a spike is emitted. It is important to note that each neuron operates independently, except when a spike is communicated between neurons.

An obvious way of implementing SNN in hardware is a one to one placement of the neurons into physical components. This approach benefits from the inherent parallel nature of spiking neural networks and allows extremely fast simulations (orders of

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